CALIFORNIA GEOLOGICAL SURVEY
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DEPARTMENT OF CONSERVATION, DARRYL YOUNG, DIRECTOR

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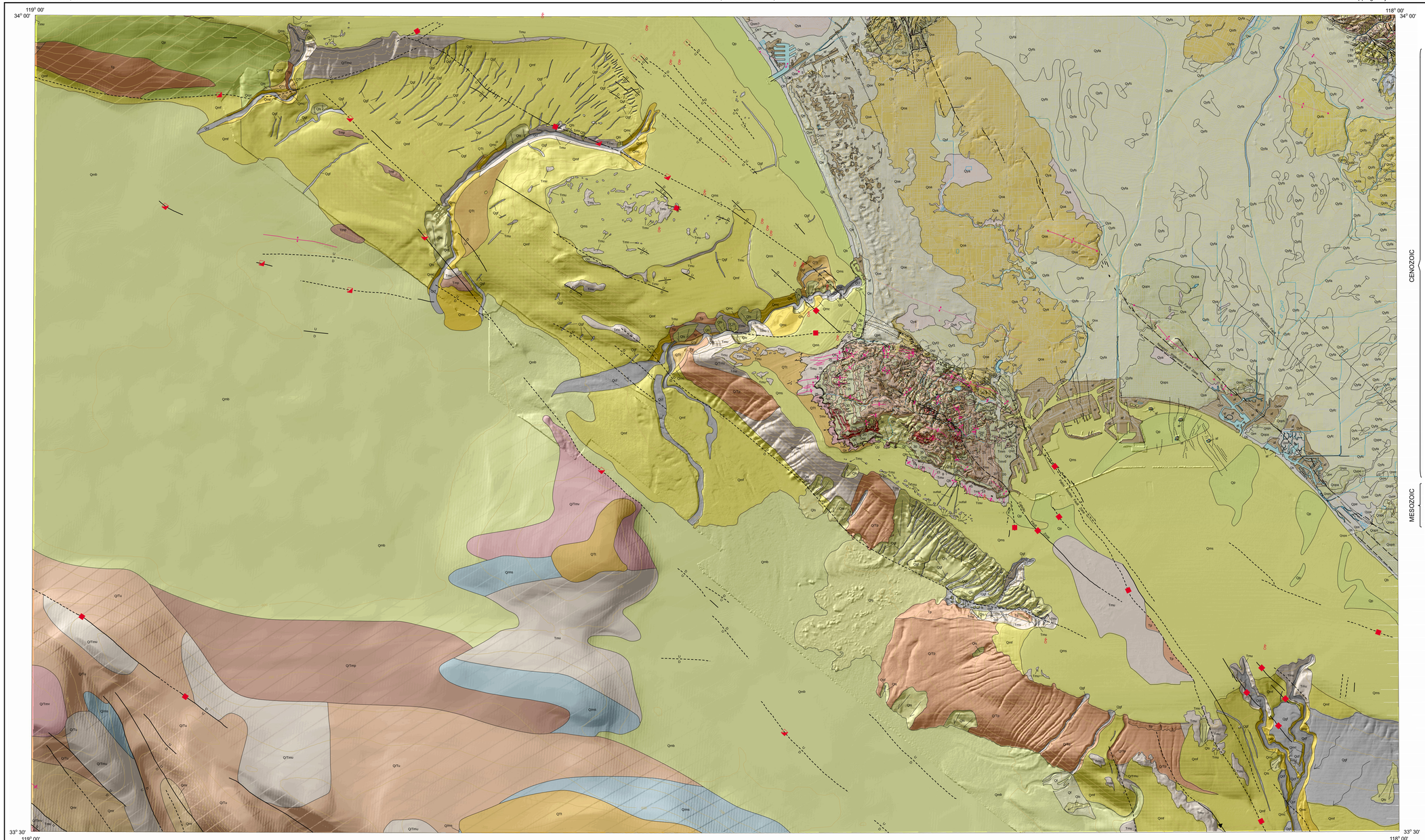
Prepared in cooperation with the U.S. Geological Survey,
Southern California Areal Mapping Project



ABBREVIATED EXPLANATION
Approximate stratigraphic relationships only: see accompanying Sheet 2 for correlation of map units and more detailed descriptions.

CENOZOIC	QUATERNARY	HOLOCENE	af	Artificial fill
			Qw	Active channel and wash deposits
			Qa	Alluvial flood plain deposits
			Qls	Landslide deposits
			Qb	Beach deposits
			Qe	Eolian deposits
			Qpe	Paralic estuarine deposits
			Qyf	Young alluvial fan and valley deposits, undivided a = sand, s = silt, c = clay
			Qyf2	Young alluvial fan deposits, unit 2
			Qyf1	Young alluvial fan deposits, unit 1
			Qya	Young alluvial flood plain deposits, unit 1
			Qye	Young eolian deposits
			Qype	Young paralic estuarine deposits
			Qof	Old alluvial fan and valley deposits, undivided a = sand, s = silt, c = clay
			Qoa	Old alluvial flood plain deposits, undivided
		PLEISTOCENE	Qoe	Old eolian deposits
			Qom	Old marine deposits, undivided
			Qop	Old paralic deposits, undivided, a = sand, s = silt, c = clay
			Qlh	La Habra Formation
				San Pedro Formation
			Qsp	San Pedro Formation, undivided
			Qspt	Timms Point Silt Member
			Qspl	Lomita Marl Member
			Qi	Inglewood Formation
	TERTIARY	PLIOCENE		Fernando Formation
			Tfu	Upper Member
			Tfl	Lower Member, Tflc = conglomerate
				Puente Formation
			Tpsc	Sycamore Canyon Member, Tpscc = conglomerate
		MIOCENE	Tpy	Yorba Member
			Tps	Soquel Member
			Tplv	La Vida Member
				Monterey Formation
			Tmm	Malaga Mudstone Member
			Tmvd	Valmonte Diatomite Member
			Tmtm	Volcanic rocks within the Monterey Formation
			Tma	Altamira Shale Member
MESOZOIC	CRETACEOUS JURASSIC		mcs	Catalina Schist

Offshore Region

Qms	Unconsolidated shelf sediment
Qmf	Unconsolidated flank sediment
Qmb	Unconsolidated basin sediment
Qmr	Unconsolidated ridge sediment
Qmc	Unconsolidated canyon sediment
Qct	Canyon terrace
Qcf	Canyon fill
Qgf	Gully fill
Qf	Fan deposits
Qls	Landslide deposits
QTt	Plio-Pleistocene terrace deposits
Qp	Pleistocene sedimentary deposits, undivided
Tp	Pliocene sedimentary rocks, undivided*
Tmp	Mio-Pliocene sedimentary rocks, undivided*
Tu	Tertiary sedimentary and volcanic rocks, undivided*
Tmu	Miocene sedimentary rocks, undivided*
Tmv	Miocene volcanic rocks*
ms	Metamorphic rocks of pre- Late Cretaceous age*

* Qᵢ = Map unit overlain by more than 3 meters of unconsolidated Quaternary sediment.

MAP SYMBOLS

Contact - accuracy of location ranges from well located to inferred. All offshore contacts are considered approximately located.

Fault - solid where well located; dashed where approximately located or inferred; dotted where concealed; queried where continuation or existence is uncertain. Where age was determined in offshore area, age symbol is shown astride fault and relative offset is shown by U, upthrown side; D, downthrown side (relative or apparent). Age of faults are indicated as follows:

- cuts strata of Holocene age
- cuts strata of Pleistocene age
- cuts strata of Quaternary age
- cuts strata of Pliocene age
- cuts Miocene or older strata

Anticlinal fold - solid where well located; dashed where approximately located or inferred; dotted where concealed. Plunge direction indicated by arrowhead on fold axis.

Synclinal fold - solid where well located; dashed where approximately located or inferred; dotted where concealed. Plunge direction indicated by arrowhead on fold axis.

Strike and dip of stratified rocks. Number indicates dip angle in degrees when known.

- 25 — Inclined beds
- 80 — Overturned beds
- Horizontal beds

Strike and dip of metamorphic and igneous foliation.

- Vertical foliation

Arrows on landslides indicate direction of movement. Hachured where headscarp is mappable.

Oil and/or gas seep.

Base Map
Base from U.S.G.S. digital line graph (DLG) data, Long Beach 30'x60' metric quadrangle. Shaded topographic base from U.S.G.S. digital elevation models (DEM's). Offshore bathymetry and terrain model from U.S.G.S. multibeam data (Dartnell and Gardner, 1999) and N.O.A.A. Projection UTM, zone 11, North American Datum 1927.

UTM grid convergence (GN), and 1981 magnetic declination (MN) at center of map
Diagram approximate

SCALE 1:100,000

MILES
KILOMETERS
THOUSAND FEET

CONTOUR INTERVAL 40 METERS
BATHYMETRIC CONTOUR INTERVAL 100 METERS

Geology compiled 2002-2003

This geologic map was funded in part by the U.S. Geological Survey National Cooperative Geologic Mapping Program, STATEMAP Award no. 02HQAG0018.

GEOLOGIC MAP OF THE LONG BEACH 30' X 60' QUADRANGLE, CALIFORNIA

Version 1.0

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2003

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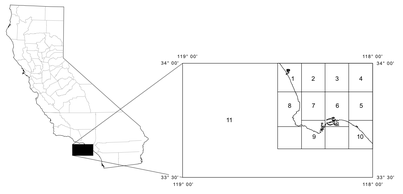
Preliminary Geologic Map available from:
http://www.conservation.ca.gov/cgs/rghm/rgm/preliminary_geologic_maps.htm



ABBREVIATED INDEX TO GEOLOGIC SOURCE DATA*

1. Venice Quadrangle
   California Division of Mines and Geology, 1998a,r; Castle, R.O., 1960a,b; Eckis, R., 1934; Irvine, P.J., 1998; Poland, J.F., and others, 1959; Tinsley, J.C., unpublished; Weber, F.H., and others, 1982.
2. Inglewood Quadrangle
   California Division of Mines and Geology, 1986a, 1998a,b; Castle, R.O., 1960b; Irvine, P.J., 1998; Poland, J.F., and others, 1959; Tinsley, J.C., unpublished; Weber, F.H., and others, 1982.
3. South Gate Quadrangle
   California Division of Mines and Geology, 1998m,n; Tinsley, J.C., unpublished.
4. Whittier Quadrangle
   California Division of Mines and Geology, 1998a,t; Saucedo, G.J., 1994.
5. Los Alamitos Quadrangle
   Bryant, W.A., 1988; California Department of Water Resources, 1961; California Division of Mines and Geology, 1986c, 1998e,f; Foster, J.F., 1996; Morton, P.K. and Miller, R.V., 1981.
6. Long Beach Quadrangle
   Bezore, S.P., and others, 1997; California Division of Mines and Geology, 1986b, 1998c,d; McNellan, T.W., and others, 1996; Poland, J.E., Piper, A.M., and others, 1956; Poland, J.F., 1959; Randell, D.H., and others,1983; Tinsley, J.C., unpublished.
7. Torrance Quadrangle
   Bezore, S.P., 1997; Bezore, S.P., and others, 1997; California Division of Mines and Geology, 1998e, 1998o,p; Clarke, S.H. and Kennedy, M.P., 1998; Cleveland, G.B., 1976; Freeman, S.T., and others, 1995; Haydon, W.D., 1998; Poland, J.F., and others, 1959; Stephenson, W.J., and others, 1995; Tinsley, J.C., unpublished; Woodring, W.P., and others,1946.
8. Redondo Beach Quadrangle
   Bezore, S.P., 1997; Bezore, S.P., and others, 1997; California Division of Mines and Geology, 1998g,h; Cleveland, G.B., 1976; Haydon, W.D., 1998; Tinsley, J.C., unpublished; Woodring, W.P., and others,1946.
9. San Pedro Quadrangle
   Bezore, S.P., 1997; Bezore, S.P., and others, 1997; Bryant, M.E., 1987; California Division of Mines and Geology, 1998j,l; Clarke, S.H. and Kennedy, M.P., 1998; Cleveland, G.B., 1976; Darrow, A.C. and Fisher, P.J., 1983; Haydon, W.D., 1998; McNellan, T.W. and others, 1996; Tinsley, J.C., unpublished; Woodring, W.P., and others,1946.
10. Seal Beach Quadrangle
    Bryant, W.A., 1988; California Division of Mines and Geology, 1986d,1998k,l; Foster, J.F., 1996; Poland, J.F., 1959.
11. Offshore area
    Greene, H.G. and Kennedy, M.P., 2003; Vedder, J.G., and others, 1986.

*See sheet 2 for complete references.

EXPLANATION FOR THE GEOLOGIC MAP OF THE LONG BEACH 30'X60' QUADRANGLE, CALIFORNIA

DESCRIPTION OF MAP UNITS

(Onshore Region)

MODERN SURFICIAL DEPOSITS - Sediment that has been recently transported and deposited in channel and washes, on surfaces of alluvial fans and alluvial plains, and on hill slopes and in artificial fills. Soil-profile development is non-existent. Includes:

af — **Artificial fill (late Holocene) -** Deposits of fill resulting from human construction, mining, or quarrying activities; includes engineered and non engineered fill. Some large deposits are mapped, but in some areas no deposits are shown.

Qw — **Active channel and wash deposits (late Holocene) -** Unconsolidated deposits of silt, sand, and gravel, mostly artificially channelized.

Qa — **Alluvial flood plain deposits (late Holocene) -** Active and recently active alluvial deposits along canyon floors. Consists of unconsolidated sandy, silty, or clay-bearing alluvium.

Qls — **Landslide deposits (Holocene and Pleistocene) -** Highly fragmented to largely coherent landslide deposits. Unconsolidated to moderately well consolidated. Most mapped landslides contain scarp area as well as slide deposit. In some areas scarp is shown separately with hatchers. Many Pleistocene age landslides were reactivated in part or entirely during late Holocene. The preponderance of the landslides in the quadrangle have occurred within the Capistrano Formation, however, there are many within the Monterey and Santiago Formations as well.

Qb — **Beach deposits (late Holocene) -** Unconsolidated beach deposits consisting mostly of well-sorted fine- to coarse-grained sand. Locally may include talus.

Qe — **Eolian deposits (late Holocene) -** Unconsolidated eolian deposits. Composed mostly of very well-sorted fine- to medium-grained sand. Gradational into older eolian deposits.

Qpe — **Paralic estuarine deposits (late Holocene) -** Unconsolidated estuarine deposits. Composed mostly of loose to moderately dense fine-grained sand, silt, and clay.

YOUNG SURFICIAL DEPOSITS—Sedimentary units that are slightly consolidated to cemented and slightly to moderately dissected. Alluvial fan deposits typically have high coarse-fine clast ratios. Young surficial units have upper surfaces that are capped by slight to moderately developed pedogenic-soil profiles. Includes:

Qyf — **Young alluvial fan and valley deposits, undivided (Holocene and late Pleistocene) -** Mostly poorly consolidated and poorly sorted clay, sand, gravel and cobble alluvial fan and valley deposits.

Qyf2 — **Young alluvial fan deposits, unit 2 (Holocene and late Pleistocene) -** Four distinct, gently sloping fan-shaped deposits overlying unit 1. Composed mostly of poorly to moderately consolidated and poorly sorted clay, silty clay and sand.

Qyf1 — **Young alluvial fan deposits, unit 1 (Holocene and late Pleistocene) -** Gently sloping, slightly dissected alluvial fan deposits. Composed mostly of poorly to moderately consolidated and poorly sorted silty clay and sand.

Qya — **Young alluvial flood plain deposits (Holocene and late Pleistocene) -** Mostly poorly consolidated, poorly sorted, permeable alluvial flood plain deposits. Composed mostly of soft clay, silt and loose to moderately dense sand and silty sand.

Qye — **Young eolian deposits (Holocene and late Pleistocene) -** Unconsolidated eolian deposits. Composed mostly of fine- and medium-grained sand.

Qype — **Young paralic estuarine deposits (Holocene and late Pleistocene) -** Unconsolidated estuarine deposits. Composed mostly of fine-grained sand and clay.

OLD SURFICIAL DEPOSITS - Sediments that are moderately consolidated and slightly to moderately dissected. Older surficial deposits have upper surfaces that are capped by moderate to well-developed pedogenic soils. Includes:

Qof — **Old alluvial fan and valley deposits, undivided (late to middle Pleistocene) -** Mostly moderately to well-consolidated, moderately sorted sand, clay, and silt.

Qoa — **Old alluvial flood plain deposits, undivided (late to middle Pleistocene) -** Fluvial sediments deposited on canyon floors. Consists of moderately well consolidated, poorly sorted, permeable, commonly slightly dissected gravel, sand, silt, and clay-bearing alluvium. Includes Reddish brown, well-cemented resistant pebbly and gravelly silty sand in the Baldwin Hills and stream terrace deposits in the Torrance quadrangle.

Qoe — **Old eolian deposits (late to middle Pleistocene) -** Poorly consolidated eolian deposits. Composed mostly of dense to very dense well-sorted fine- to coarse-grained sand and silty sand.

Qom — **Old marine deposits, undivided (late to middle Pleistocene) -** Poorly consolidated marine deposits. Composed mostly of fine- to coarse-grained sand.

Qop — **Old paralic deposits, undivided (late to middle Pleistocene) -** Mostly poorly sorted, moderately permeable, reddish-brown, interfingered strandline, beach, estuarine and colluvial deposits composed of siltstone, sandstone, and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift (a = sand, s = silt, c = clay). Locally may include older alluvium.

SEDIMENTARY AND VOLCANIC BEDROCK UNITS

Qlh — **La Habra Formation, undivided (late Pleistocene) -** Siltstone, thick-bedded friable sandstone, pebbly sandstone, and pebble-cobble conglomerate; locally abundant clasts of platy white siltstone.

San Pedro Formation (early Pleistocene) -

Qsp — **San Pedro Formation, undivided -** Poorly consolidated fine- to coarse-grained sand and silty sand interbedded with thin beds and lenses of gravel. Marine. Also includes fluvial sand and gravel with local beds of clayey-silt in the Baldwin Hills.

Qspt — **Timms Point Silt Member -** Dense sandy silt and silty sand.

Qspl — **Lomita Marl Member -** Marl and calcareous sand and gravel.

Qi — **Inglewood Formation (lower Pleistocene) -** Well-bedded siltstone with interlayered beds of very fine-grained sandstone; locally abundant calcareous and limonitic concretions. Marine.

Fernando Formation (Pliocene and Pleistocene) - Consisting of:

Tfu — **Upper Member -** Massive friable silty and pebbly sandstone interbedded with thin beds of siltstone, massive pebble conglomerate at base; locally abundant angular chips of platy white siltstone. Locally contains limy concretions.

Tfl / Tflc — **Lower Member -** Massive silty sandstone with interbedded pebbly sandstone and conglomerate. Basal conglomerate contains locally abundant angular chips of platy white siltstone. Tflc = conglomerate and sandstone interbedded with Tfl. Includes rocks mapped as Repetto in the Torrance quadrangle by Woodring and others, 1946.

Puente Formation (upper Miocene) - Consisting of:

Tpsc / Tpscc — **Sycamore Canyon Member -** Sandstone with interbedded pebble-cobble conglomerate and sandy siltstone. Tpscc = pebble-cobble conglomerate and pebbly sandstone interbedded with Tpsc.

Tpy — **Yorba Member -** Platy diatomaceous siltstone with interbeds of sandstone, limestone and marl.

Tps — **Soquel Member -** Thick-bedded to massive graded sandstone and siltstone; local lenses of pebble-cobble conglomerate in upper part.

Tplv — **La Vida Member -** Laminated to platy siltstone with interbedded pebbly sandstone; limestone and altered tuff beds in lower portion.

Monterey Formation (middle and upper Miocene) - Constisting of:

Tmm — **Malaga Mudstone Member -** Radiolarian mudstone and diatomite.

Tmvd — **Valmonte Diatomite Member -** Diatomaceous shale, mudstone, and diatomite with beds and lenses of hard, resistant silicified limestone and shale and resistant zones of chert.

Tma — **Altamira Shale Member -** Siliceous shale, silty and sandy shale, cherty shale, chert, siltstone, bituminous shale, diatomaceous shale, diatomite, phosphatic shale, tuffaceous shale, limestone, sandstone, conglomerate , breccia, and silicified limestone and shale.

Tmv — **Volcanic rocks within the Monterey Formation (middle Miocene) -** Consists of basalt, andesite, volcanic breccia, and tuff breccia mainly or completely intrusive.

mcs — **Catalina Schist (pre- late Cretaceous) -** Consists of quartz-chlorite schist, quartz-sericite schist, and quartz-glaucophane schist.

(Offshore Region)

Qms — **Unconsolidated shelf sediment (late Holocene) -** Deposits of mostly unconsolidated sand and silt on the shelf.

Qmf — **Unconsolidated flank sediment (late Holocene) -** Deposits of mostly mud on the slope.

Qmb — **Unconsolidated basin sediment (late Holocene) -** Deposits of mostly mud on the basin floor.

Qmr — **Unconsolidated ridge sediment (late Holocene) -** Deposits of mostly mud on the ridge.

Qmc — **Unconsolidated canyon sediment (late Holocene) -** Deposits of mostly mud on the canyon walls.

Qct — **Canyon terrace (Holocene and Pleistocene) -** Deposits of mixed gravel, sand, and mud on canyon formed terrace.

Qcf — **Canyon fill (Holocene and Pleistocene) -** Deposits of mixed gravel, sand, and mud on the canyon floor.

Qgf — **Gully fill (late Holocene) -** Deposits of mostly mud in gully.

Qf — **Fan deposits (Holocene and Pleistocene) -** Deposits of gravel, sand, and mud at base of slope at mouths of submarine canyons and gullies.

Qls — **Landslide deposits (Holocene and Pleistocene) -** Highly fragmented to largely coherent landslide deposits. Unconsolidated to moderately well consolidated. Most mapped landslides include scarp area as well as slide deposit. In some areas scarp is shown separately with pattern. Preponderance of landslides found in submarine canyons and on steep slopes.

Qp — **Pleistocene sedimentary deposits, undivided (Pleistocene) -** Deposits of mostly unconsolidated sand in nearshore areas of continental shelf.

QTt — **Plio-Pleistocene terrace deposits (Pliocene and Pleistocene) -** Deposits of unconsolidated gravel and sand on low-stand erosional platforms.

Tp — **Pliocene sedimentary rocks, undivided* (Pliocene) -** Sandstone and siltstone, heavily gullied where mapped on the slope.

Tmp — **Miocene-Pliocene rocks, undivided* -** Plutonic and hypabyssal rocks found on the outer banks.

Tu — **Tertiary sedimentary and volcanic rocks, undivided* (Tertiary) -** Sandstone, mudstone, and volcanic rocks found on the outer banks.

Tmu — **Miocene sedimentary rocks, undivided* (middle and upper Miocene) -** Mostly diatomaceous mudstones of the Monterey Formation.

Tmv — **Miocene volcanic rocks* (middle and upper Miocene) -** Mostly within the Monterey Formation.

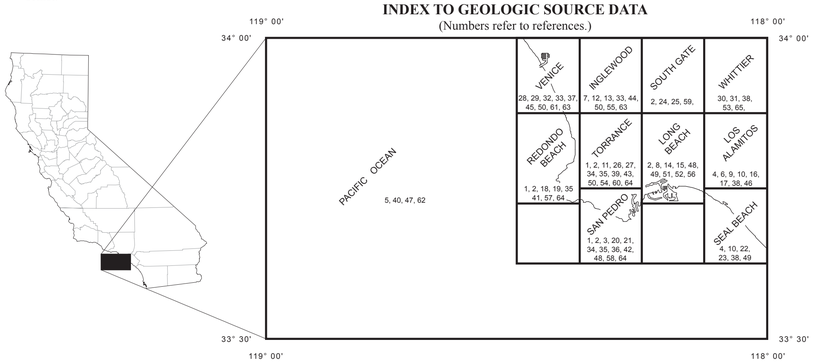
ms — **Metamorphic rocks of pre-Late Cretaceous age* (Jurassic - Cretaceous) -** Mainly Franciscan Complex.

* Q/ = Map unit overlain by more than 3 meters of unconsolidated Quaternary sediment.

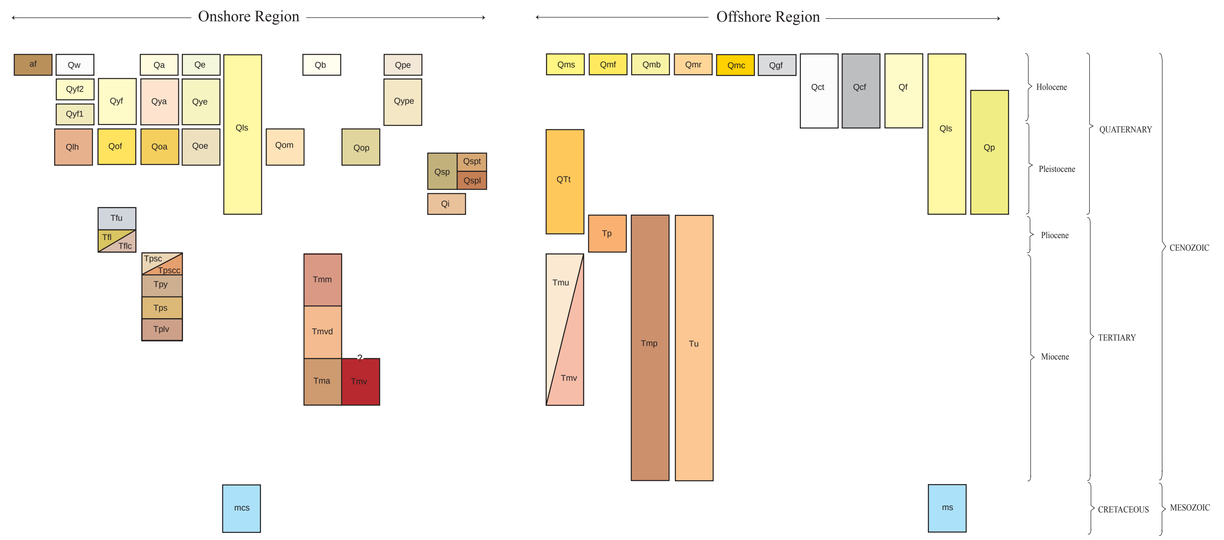
Prepared in cooperation with the U.S. Geological Survey, Southern California Areal Mapping Project

INDEX TO GEOLOGIC SOURCE DATA

(Numbers refer to references.)



CORRELATION OF MAP UNITS



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